SOFO VII/MuST UNIVERSAL READING UNIT

USER MANUAL

Engineered by FiberSensing

SOFO VII/MuST Universal Reading Unit
User Manual

Measurement Unit Version: v1.1
User Manual version: v1.1

Any questions or comments regarding this guide please report to:
support@smartec.ch

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2. TECHNICAL DETAILS

GENERAL INFORMATION

The SOFO VII/MuST Universal Reading Unit is a continuous swept laser scanning measurement unit for interrogating SOFO and fiber Bragg grating (FBG) sensors. It includes a NIST traceable wavelength reference that provides continuous calibration to ensure system accuracy over long term operation. The high dynamic range and high output power allows high resolution to be attained even for long fiber leads and lossy connections.
Five SOFO sensors can be measured with each optical channel with the use of a SOFO MUX 1x5. Multiple FBG sensors can be connected in series in each optical fiber. This, in combination with the four or eight optical channels with parallel acquisition, make the SOFO VII/MuST Universal Reading Unit particularly suited for large scale sensing networks, acquiring a large number of sensors of different technologies simultaneously.

Note: The SOFO sensors cannot be connected directly to the SOFO VII. The only way to measure a SOFO sensor is to plug it to a channel of the SOFO MUX 1x5 or using a hybrid patch cord with a E2000/APC connector on one side (to the reading unit) and a E2000/PC (to the SOFO sensor). Never connect a SOFO sensor directly to a channel of the reading unit, this can damage the core of fibers of both connectors.

This Manual applies to the following equipments:

PN S10.2021-4CH
SOFO VII/MuST Universal Reading Unit • 4 OC • Standard Temperature Operation Range
PN S10.2021-8CH
SOFO VII/MuST Universal Reading Unit • 8 OC • Standard Temperature Operation Range
PN S10.2021-MUX
SOFO MUX 1x5

SYSTEM COMPONENTS

The SOFO VII/MuST Universal Reading Unit set includes:

- Measurement Unit
- Power cord
- Adapter protection caps
- SOFO Reference sensor
- SOFO MUX 1x5 (optional)

SOFO VII/MUST READING UNIT TECHNICAL DATA

PERFORMANCE

	SOFO Sensors Measurement	MuST /FBG Sensor Measurement
Measurement Resolution	2 μm RMS	1 pm
Linearity/Accuracy	< 2‰	2 pm
Measurement Range	Max. 50 mm	100 nm (1500 to 1600 nm)
Calibration	None, not required	NIST traceable wavelength reference
Measurement time	< 2 s (inc SDB writing) per channel	< 2 s (inc SDB writing) per channel
Availlable channel count	4 or 8 channels total, software configurable between SOFO and MuST	

TECHNICAL CHARACTERISTICS

AC power supply	230 V 50 Hz / 110 V 60 Hz Auto detect
External connections	Ethernet connection, 8 optical ports, power supply, display and screen (optional)
Data logger capacity	Typical 5 year of data with measurements every 1h
Dimensions	500 mm x 500 mm x 210 mm
Weight	~25 Kg
Operating temperature	10 ºC to +40 ºC -40 ºC to + 40 ºC with heating option*
Humidity	90% non-condensed
Protection Index	IP 66**

** optional*

*** if the base of the SOFO VII is properly drilled and hermetic gland nuts are used*

SOFO MUX 1X5 TECHNICAL DATA

PERFORMANCE

Channel Multiplexing	1x5
Operating Range	
Channel 1	1501 to 1519 nm
Channel 2	1521 to 1539 nm
Channel 3	1541 to 1559 nm
Channel 4	1561 to 1579 nm
Channel 5	1581 to 1599 nm
Insertion loss	<1.5 dB

TECHNICAL CHARACTERISTICS

Connectors to Measurement Unit	E2000/APC
Connectors to SOFO Sensors	E2000/PC
Dimensions	163mm x 103 mm x 53 mm
Weight	0.43 Kg
Material	Aluminum
Operating temperature	-25 to 70 ºC
Humidity	< 90% at 40 ºC

3. REGULATORY AND CERTIFICATION CONSIDERATIONS

ENVIRONMENT CONSIDERATIONS

DISPOSAL OF YOUR OLD APPLIANCE

When the attached symbol combination - crossed-out wheeled bin and solid bar symbol is attached to a product it means the product is covered by the European Directive 2002/96/EC and is applicable in the European Union and other countries with separate collection systems.

All electrical and electronic products should be disposed of separately from the municipal waste stream or household via designated collection facilities appointed by the government or the local authorities. The correct disposal of your old appliance will help prevent potential negative consequences for the environment and human health. For more detailed information about disposal of your old appliance, please contact your city office, waste disposal service or distributor that purchased the product.

FiberSensing is a manufacturer registered in the ANREEE - "Associação Nacional para o Registo de Equipamentos Eléctricos e Electrónicos" under number PT001434. FiberSensing celebrated a "Utente" type contract with Amb3E - "Associação Portuguesa de Gestão de Resíduos de Equipamentos Eléctricos e Electrónicos", which ensures the transfer of Electrical and Electronic appliance waste management, i.e. placing Electronic and Electrical appliances in the Portuguese market, from the manufacturer (FiberSensing) to Amb3E

LASER SAFETY

The SOFO VII/MuST Universal Reading Unit product contains a laser in its core. A laser is a light source that can be dangerous to people exposed to it. Even low power lasers can be hazardous to a person's eyesight. The coherence and low divergence of laser light means that it can be focused by the eye into an extremely small spot on the retina, resulting in localized burning and permanent damage.

The lasers are classified by wavelength and maximum output power into the several safety classes: Class 1, Class 1M, Class 2, Class 2M, Class 3R and Class 4.

SYMBOLS

Warning symbol

Class 1 Laser symbol

Figure 1 – Laser Symbols.

CLASS 1 LASER

The SOFO VII/MuST Universal Reading Unit is a class 1 laser product:
«Any laser or laser system containing a laser that cannot emit laser radiation at levels that are known to cause eye or skin injury during normal operation. »
It is safe under all conditions of normal use. No safety requirements are needed to use Class 1 laser devices. This product contains a laser within an enclosure that prevents exposure to the radiation and that cannot be opened without shutting down the laser.

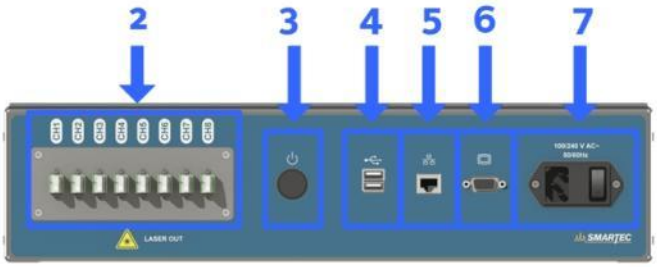
GENERAL PRECAUTIONS CONSIDERATIONS

Everyone who uses a laser's equipment should be aware of the risks.
The laser radiation is not visible to the human eye but it can seriously damage user's eyesight.
The laser is enabled when the measurement unit is turned on.
Users should never put their eyes at the level of the horizontal plane of the optical adapters of the measurement unit or uncovered optical connectors.
Adequate eye protection should always be required if there is a significant risk for eye injury.
Do not attempt to open or repair a malfunction measurement unit. It must be returned to Smartec for repair and calibration.

4. OPERATION

CONNECTORS

Front View



Bottom View

Figure 2 – Measurement unit Buttons and Connectors.

The connectors and buttons on Figure 2 are:

1. Power and Status LEDs
2. Optical Output Connectors
3. ON/Off Button
4. USB Connectors
5. LAN Connector
6. VGA Connector
7. Power Connector

TYPE OF CONNECTORS

The SOFO VII Reading unit has 4 or 8 E2000/APC Optical Output Connectors to which can be plugged only E2000/APC connector. The E2000/APC connectors and Mating are identified by the green color, in the Figure 3 are shown an E2000/APC connector and an E2000/APC Mating adapter:

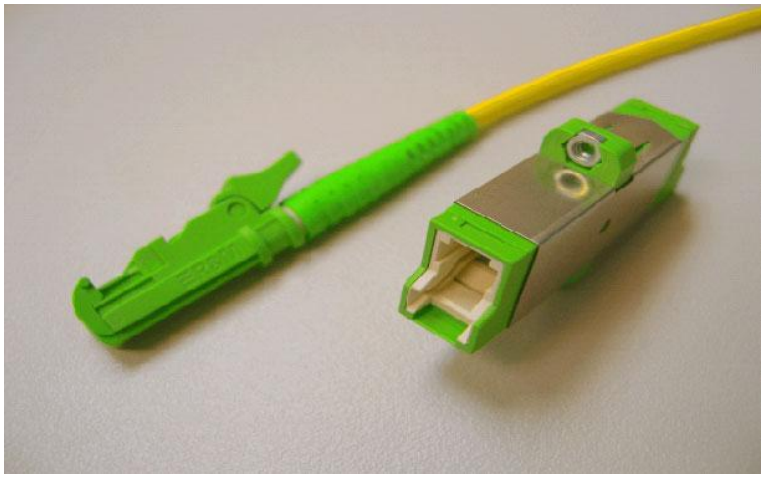


Figure 3 - E2000/APC connecter and E2000/APC mating adapter.

The SOFO VII Reading unit can measure FBG sensors (identified by a green E2000/APC connector) and SOFO sensors (identified by a blue E2000/PC connector) plugged to the SOFO MUX 1x5 , in the Figure 4 are shown a E2000/APC connector (FBG) and E2000/PC Connector (SOFO):

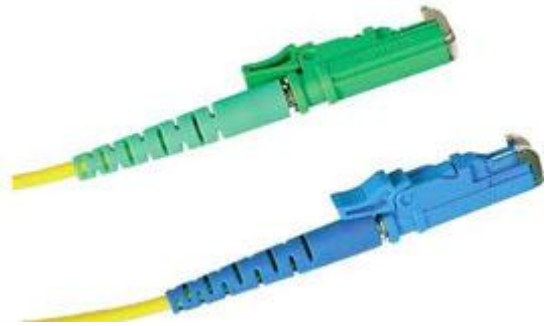


Figure 4 - E2000/APC connecter (FBG) and E2000/PC connecter (SOFO).

SETTING UP

POWER SUPPLY

To start the SOFO VII/MuST Universal Reading Unit connect the supplied power cable to 100 - 240 V power line and to the measurement unit Power Connector (7 on Figure 2). Then

switch the power switch to its ON position. To acknowledge proper power supply, the power LED will turn green during 2 seconds after connecting the power supply.

OPTICAL CONNECTORS

The SOFO VII/MuST Universal Reading Unit can be purchased either with 4 or 8 E2000/APC optical connectors. Number 2 on Figure 2 exemplifies an 8 connector removable base.

Attention should be paid to the cleaning of the optical connectors. A dirty connector can compromise the measurement and will degrade the measurement unit performance. It is advisable to frequently clean the connectors using appropriate tools (see Cleaning Procedure on page 15).

SWITCHING ON

Pressing the "ON/OFF" button (3 on Figure 2) will start the unit. The Status LED (1 on Figure 2) will start blinking at 2Hz. After approximately 30 seconds it will start blinking at 1Hz. This means that the measurement unit is already on and responsive, but the optoelectronic module is still warming up. After approximately one and a half minutes (90 s) it should stay on permanently. This means that the measurement unit is able to measure.

Note: If the unit does not start correctly, the status led will blink faster. If this happens please contact Smartec technical support.

SWITCHING OFF

To avoid accidental shutting-down the measurement unit, it is necessary to press the "ON/OFF" button (2 on Figure 2) during 4 seconds to power-off the unit.

INTERFACE

To operate the measurement unit a Monitor and a mouse and keybord should be connected to the VGA connector (6 on Figure 2) and to the USB ports (4 on Figure 2).

The measurement unit operates on a Windows 7 Professional environment.

Please refer to the software manual for further details.

CONTROL

The SOFO VII/MuST Universal Reading Unit measurement unit can be fully controlled using two software:

- BRAGGMONITOR: to control the status of the reading unit, to see the optical traces of each physical channel, to take some measurements of the FBG sensors connected. Please refer to the BraggMONITOR software manual for further details.
- SDB: it is a software for long term static monitoring. I can measure both SOFO sensors and FBG sensors connected to the reading unit. Please refer to the SDB software manual for further details.

SOFO MUX 1X5

The SOFO MUX 1X5 is a device that allows to measure up to 5 SOFO sensors on a single channel of the reading unit. It is an external 1x5 splitter, a picture of the device is the following:

Figure 5 – SOFO MUX 1x5.

The connection schema of the SOFO MUX 1X5 to the SOFO VII is the following:

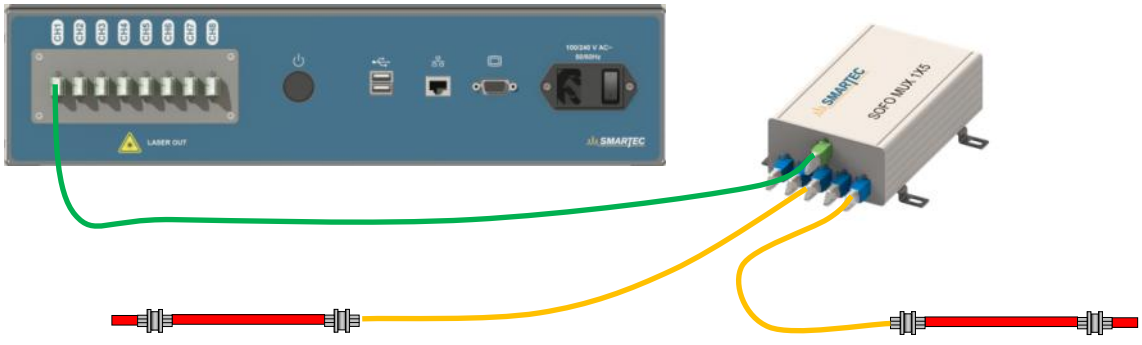


Figure 6 – Connection scheme between the SOFO VII and the SOFO MUX 1x5.

Note The SOFO MUX 1X5 has six connectors: five E2000/PC for the SOFO sensors and one E2000/APC to which must be connected the patch cord attached to a channel of the SOFO VII. All the SOFO sensors connected to the MUX must mount an E2000/PC connector and the patch cord used to connect the MUX to the SOFO VII must have on both sides E2000/APC connectors. If this is not respected there is the possibility to irretrievably damage the core of the fiber and as consequence it will be impossible to measure the SOFO sensors.

The characteristics of SOFO MUX are shown section SOFO MUX 1x5 Technical Data on page 8.

CLEANING PROCEDURE

Proper performance of a fiber optic connection is strongly dependant on the cleanliness of the mated ferrules. After repeated matings, however, or when degraded performance is observed, it may become necessary to clean the individual ferrules and mating sleeve. In this section are outlined the proper cleaning and inspection procedures to help ensure optimal connector performance.
When a Measurement Unit is repeatedly being plugged in and out with optical connectors, it is very important that the connectors are cleaned prior to any connection. If not, dust and moister can be deposited in the measurement unit adaptor and this will compromise measurements. On Figure 7 a picture of a magnified connector is presented. The dark gray circle corresponds to the fiber cladding and the small light gray circle is the core of the fiber. One picture for a clean connector and one picture for a dusty connector are presented.

Clean connector Dirty connector

Figure 7 – In the figure are shows two connectors, on the left there is a clean conector and on the right a dirty one.

The most common effect of dirt on the connections is that there is a large amount of broad band light that is being reflected at the connection, at both directions, meaning that the dynamic range for measuring becomes smaller.

On the market there are several tool aimed to clean the connectors, some of them are:

- Dust and shutter caps
- Isopropyl alcohol
- Cotton swabs

- Soft tissues
- Pipe cleaner
- Compressed air

Before reporting the general procedure for cleaning connectors it is important to highlight some reminders that shall always be kept into account:

- Always turn off any laser sources before you inspect fiber connectors
- Always inspect the connectors or adapters before you clean.
- Always inspect and clean the connectors before you make a connection.
- Always use the connector housing to plug or unplug a fiber.
- Always keep a protective cap on unplugged fiber connectors.
- Always store unused protective caps in a sealable container in order to prevent the possibility of the transfer of dust to the fiber. Locate the containers near the connectors for easy access.

Some warnings as well:

- Never use alcohol or wet cleaning without a way to ensure that it does not leave residue on the end face. It can cause damage to the equipment.
- Never look into a fiber while the system lasers are on.
- Never use unfiltered handheld magnifiers or focusing optics to inspect fiber connectors.
- Never connect a fiber to a fiberscope while the system lasers are on.
- Never touch the end face of the fiber connectors.
- Never twist or pull forcefully on the fiber cable.
- Never touch the clean area of a tissue, swab, or cleaning fabric.
- Never touch any portion of a tissue or swab where alcohol was applied.
- Never touch the dispensing tip of an alcohol bottle.
- Never use alcohol around an open flame or spark; alcohol is very flammable.

The here below section describes the connector cleaning process.

1. Inspect the fiber connector, component, or bulkhead with a fiberscope with a proper E2000 adapter.
2. If the connector is dirty, clean it with a dry cleaning technique.
3. Inspect the connector.
4. If the connector is still dirty, repeat the dry cleaning technique.
5. Inspect the connector.
6. If the connector is still dirty, clean it with a wet cleaning technique followed immediately with a dry clean in order to ensure no residue is left on the end-face.

Note: Wet cleaning is not recommended for bulkheads and receptacles. Damage to equipment can occur.

7. Inspect the connector again.
8. If the contaminate still cannot be removed, repeat the cleaning procedure until the endface is clean.

Here below dry and wet cleaning technique are described:

DRY CLEANING TECHNIQUE

NECESSARY TOOL

Lint-free wipes, preferably clean room quality.

Figure 8 – Lint-free wipes.

STARTING PRE-CAUTION

Read the reminders and warnings before you begin this process.

1. Make sure that the lasers are turned off before you begin the inspection.
2. Remove the protective cap using the E2000 service adapter.
3. Fold the wipe into a square about 4 to 8 layers thick, see Figure 8.
4. Inspect the connector with a fiberscope.

If the connector is dirty, clean it with a lint-free wipe.

Attention!: Be careful not to contaminate the cleaning area of the wipe with your hands or on a surface during folding.

5. Lightly wipe the ferrule tip in the central portion of the wipe with a figure 8 motion.

Attention!: Do not scrub the fiber against the wipe. If you do it, it can cause scratches and more contamination.

6. Repeat the figure 8 wiping action on another clean section of the wipe.
7. Properly dispose of the wipe.
8. Inspect the connector again with the fiberscope.

9. Repeat this process as necessary.

WET CLEANING TECHNIQUE

NECESSARY TOOL

Lint-free wipes, preferably clean room quality, and 99% isopropyl alcohol.

1. Make sure that the lasers are turned off before you begin the inspection.
2. Remove the protective cap using the E2000 service adapter.
3. Inspect the connector with a fiberscope.
4. Fold the wipe into a square, about 4 to 8 layers thick.
5. Moisten one section of the wipe with one drop of 99% alcohol. Be sure that a portion of the wipe remains dry.
6. Lightly wipe the ferrule tip in the alcohol moistened portion of the wipe with a figure 8 motion. Immediately repeat the figure 8 wiping action on the dry section of wipe to remove any residual alcohol.

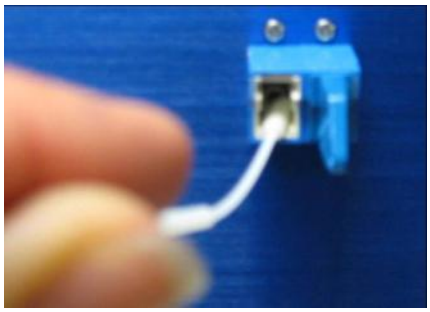
Attention!: Do not scrub the fiber against the wipe, doing so can cause scratches.

7. Properly dispose of the wipe. **Never reuse a wipe.**
8. Inspect the connector again with a fiberscope.
9. Repeat the process as necessary.

To clean an optical measurement unit adapter, use an appropriate cotton swab (there are several fiber clean swabs in the market frequently used for telecom) embedded in isopropyl alcohol.

1. Ensure the reading unit is disconnected and switched off
2. put some isopropyl alcohol on cleaning stick
3. Push the metallic protection inside the connector with the help of the cleaning stick. You with then see a white plastic ring
4. insert the stick inside the ring and gently clean the inner part of the connector rotating the swab always on the same direction.

How to clean an FC connector of a reading unit



How to clean an E2000 connector of a reading unit

Figure 9 – Cleaning the connectors.

FUSE REPLACEMENT

Electrical shorts may cause fuse failure and when that happens it is necessary to replace the fuse located on the Power Connector (Figure 2). To replace the fuses release the top and bottom springs of the fuse's support and then remove the piece (Figure 10).

Realeasing the top and bottom springs

Fuses on the piece

Figure 10 – Replacing the fuse.

Fuse characteristics:

1. Rated voltage: 250 Volt AC
2. Interrupting rate: 2 Ampere
3. Number of fuses: 2